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A REVIEW OF SOME EXPERIMENTS ON THE SYNTHESIS OF "JEEWANU"

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SUMMARY

Bahadur has reported synthesizing living globules called "jeewanu." These experiments, and attempts to repeat them, are critically reviewed. It is concluded that insufficient evidence has been advanced to prove that jeewanu are alive.

INTRODUCTION

Bahadur has reported the synthesis of inorganic and organic living globules which he has called "jeewanu," the Sanskrit word for "particles of life." These experiments and the philosophy underlying their interpretation have been the subject of many publications (refs. 1-7). Since one objective of exobiology is to retrace the path of chemical evolution in the laboratory, it is of interest to examine these experiments with care. The purpose of this paper is to review critically some experiments in which jeewanu are synthesized.

Bahadur believes that life is an inherent property of matter which can manifest itself when conditions are appropriately arranged (refs. 1, 2, and 7). He has defined living units as those which grow, multiply, and are metabolically active in a "systematic, harmonious, and synchronized manner" (refs. 1, 2, and 5). The question considered herein is not whether these three criteria are an adequate definition of life, but whether the jeewanu satisfy these criteria.

Three kinds of jeewanu were prepared (refs. 2-7). One group of jeewanu was inorganic (ref. 5), whereas the other two were organic (refs. 3 and 4). Of the organic jeewanu, one group was produced photochemically (ref. 3) whereas the other (ref. 4) was prepared from thermal polymers of amino acids (proteinoid) as described by Fox (ref. 8).

INORGANIC JEEWANU

The synthesis of jeewanu composed of 88 percent ash, 4.2 percent carbon, and 0.25 percent nitrogen has been reported (refs. 5 and 7). Of the copper present, 61.14 percent was cuprous oxide. No protein, peptides, or amino acids were present. Although it was stated that these jeewanu grow, multiply, and have metabolic activity, no convincing evidence was presented (refs. 5 and 7).

It may be noted that other inorganic structures have been produced and described as living by Kalinenko (refs. 9 and 10). These structures lack protein, amino acids, purine or pyrimidine bases, and certain enzyme activities. Confirmatory reports by other workers are lacking.

Presently known scientific principles of biology and biochemistry cannot account for living inorganic units. The postulated existence of these living units has not been proved.

PHOTOCHEMICALLY PREPARED JEEWANU

It has been reported that peptides are formed when aqueous solutions of amino acids are exposed to light in the presence or absence of inorganic catalysts (refs. 1 and 11). Under the same conditions, some amino acids, such as tyrosine or glycine, can be converted photochemically into other amino acids (refs. 1 and 11). Perti, Bahadur, Santamaria, Briggs, and Agrawal have reported that photosynthesis of amino acids can occur in sterilized aqueous mixtures of simple carbon compounds (such as paraformaldehyde or citric acid), a nitrogen source (such as ammonium salts, nitrates, or molecular nitrogen), and one or more (sometimes colloidal) metallic catalysts, such as iron or molybdenum (refs. 1 and 12-16). The identification of the synthesized products as amino acids in these experiments was not conclusive because, in most experiments, one-dimensional paper chromatography was the only analytical method used. In addition, the implied fixation of molecular nitrogen under these conditions (refs. 13-15) is unlikely from a chemical standpoint(ref. 17).

It has been further reported that jeewanu were formed when these sterile solutions were exposed to 500 to 1000 hours irradiation with visible light (ref. 3). During exposure, the jeewanu reportedly increased in size (from 0.25-0.5 μ to 1-1.5 μ in diameter) and in number (6- to 65-fold).

PROTEINOID JEEWANU

Proteinoid jeewanu have also been prepared. The proteinoid consists of amino acids polymerized by heat under anhydrous conditions (ref. 8). It had been shown earlier by Fox (ref. 8) that when proteinoid is partially dissolved in hot water, the mixture boiled for 10 seconds, and the hot clear supernatant decanted and allowed to cool, microspheres with an average diameter of a few microns or less were formed.

Proteinoid jeewanu were prepared by seeding a proteinoid-containing nutrient medium with proteinoid microspheres (ref. 4). It is difficult to describe a typical proteinoid jeewanu experiment since the methods varied considerably from one experiment to the next. In most experiments, ascorbic acid, ammonium molybdate or molybdic acid, and a mineral solution were included in the nutrient medium. These mixtures were then exposed to sunlight as an energy source for eight hours a day and shaken daily. Molybdenum was included to serve as a photosensitizer, that is,to capture some of the energy of the sunlight and later reemit it within the solution. It has been reported that the microspheres or jeewanu placed in this medium and irradiated with visible light increased in number and size within two weeks. One protocol from reference 4 is shown in figure 1. Depending on the experimental conditions, Bahadur reported an increase in the number of jeewanu ranging from 2- to 28-fold within two weeks (ref. 4).

In evaluating the organic jeewanu, one must consider whether Bahadur's three criteria of growth, multiplication, and metabolic activity have been met. The evidence presented on these three points is on the whole unconvincing.

Growth, defined as an increase in mass, was not rigorously demonstrated, but was inferred from an apparent increase in the average diameter of the jeewanu measured microscopically. When Young and McCaw (ref. 18) repeated the proteinoid jeewanu experiment, no increase in the size of the jeewanu was observed (ref. 18). Unequivocal proof of growth would be the demonstration of an increase in the dry weight or nitrogen content of the globules. Such determinations have not been reported.

Multiplication, that is,an increase in the number of jeewanu, was observed following daily shaking and irradiation for a few days, weeks, or months. Young and McCaw (ref. 18) observed an increase in the number of units only when the mixtures were shaken as directed (ref. 4); no increase in number was observed when the mixtures were not shaken (ref. 18). It was concluded that vigorous shaking broke the microspheres into smaller particles (ref. 19) and accounted for their increased number. In this connection, Fox has reported that proteinoid microspheres can form buds which are detachable by agitation (ref. 20). Whether or not this mode of multiplication also occurred in the jeewanu experiments is an open question.

There is no convincing evidence presented that indicates proteinoid jeewanu possess metabolic activity.

The implied basis of the proteinoid jeewanu experiments (refs. 4 and 7) was Bahadur's earlier photochemical work (refs. 2 and 3). The photochemical synthesis and interconversion of amino acids as well as the photochemical fixation of molecular nitrogen had been reported to occur under conditions similar to those used for the growth of jeewanu (refs. 2-4, 7, 14, and 15), but whether these phenomena did occur in the jeewanu experiments is not clear. No concrete evidence is offered on this critical point. If these processes were occurring in the presence of the proteinoid jeewanu, it would provide a mechanism for an increase in the mass of the system as a whole.

In addition to this unresolved basic point, there are other difficulties in interpreting the jeewanu experiments. One is the confusing manner in which the experimental procedures were presented. For instance, it is not apparent why the substances in the nutrient medium (fig. 1) were included or why they varied in relative amounts from one experiment to the next; a systematic study of these variations and an assay of their results were not done.

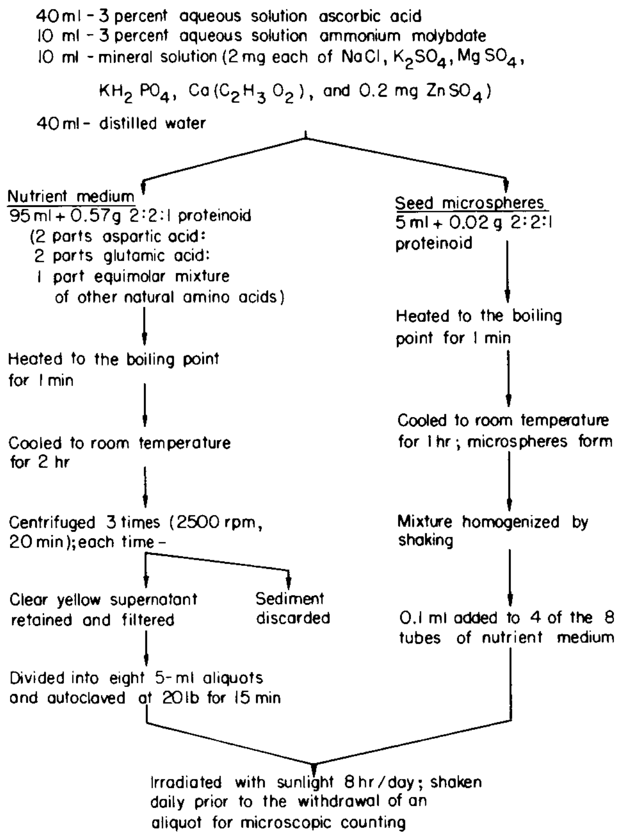

Figure 1.- One of Bahadur's procedures for preparing proteinoid "jeewanu" (ref. 4).

The sterility of the mixtures is another point in question. It is stated that the mixtures were sterile, but although the nutrient medium was sterilized by autoclaving, the seed microspheres apparently were not (fig. 1).

A basic defect in these experiments was the inadequate chemical description of many of the substances used. To cite one or two examples, the preparation of the "molybdenum oxide sol" was not described in enough detail to allow another person to prepare it. One also wonders what happened to the ascorbic acid during the autoclaving process. This compound is very heat-labile, and can be reduced and cleaved easily between the second and third carbon atoms, particularly in the presence of small amounts of metals (ref. 21). The chemically uncharacterized "clear yellow supernatant" (fig. 1) used as the nutrient medium may have contained resulting small carbon skeletons which could have participated in the photochemical synthesis of amino acids. All in all, the large number of chemically undefined substances in the proteinoid jeewanu experiments preclude a meaningful interpretation.

CONCLUSIONS

Inorganic and organic globules called jeewanu have been synthesized. Properties attributed to the jeewanu include growth, multiplication, and metabolic activity. The evidence advanced to support these conclusions is insufficient in that objective, definitive experiments have not been done. At present, the nature and properties of the jeewanu remain to be clarified.

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